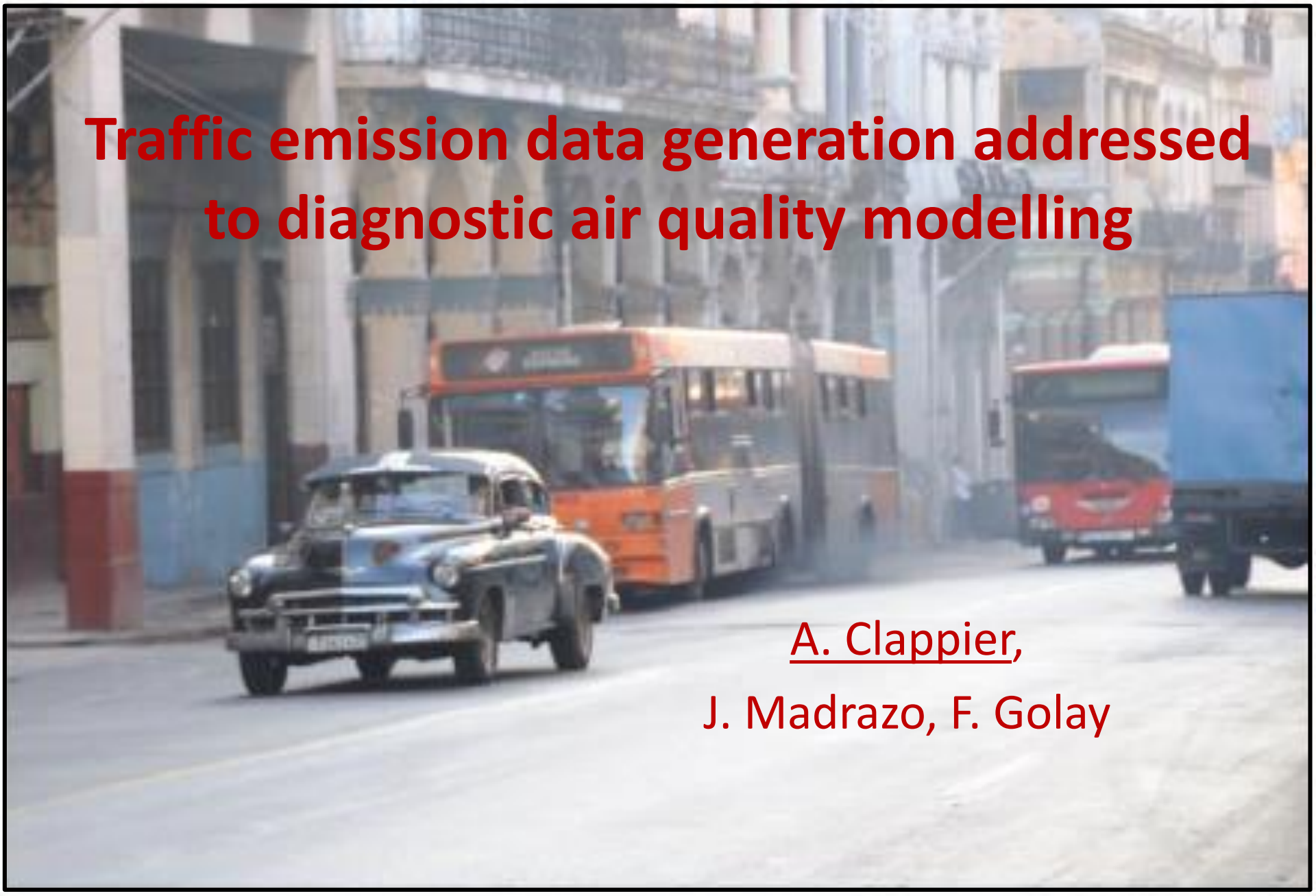


Traffic emission data generation addressed to diagnostic air quality modelling

A. Clappier,

J. Madrazo, F. Golay

Cuba and Energy supply

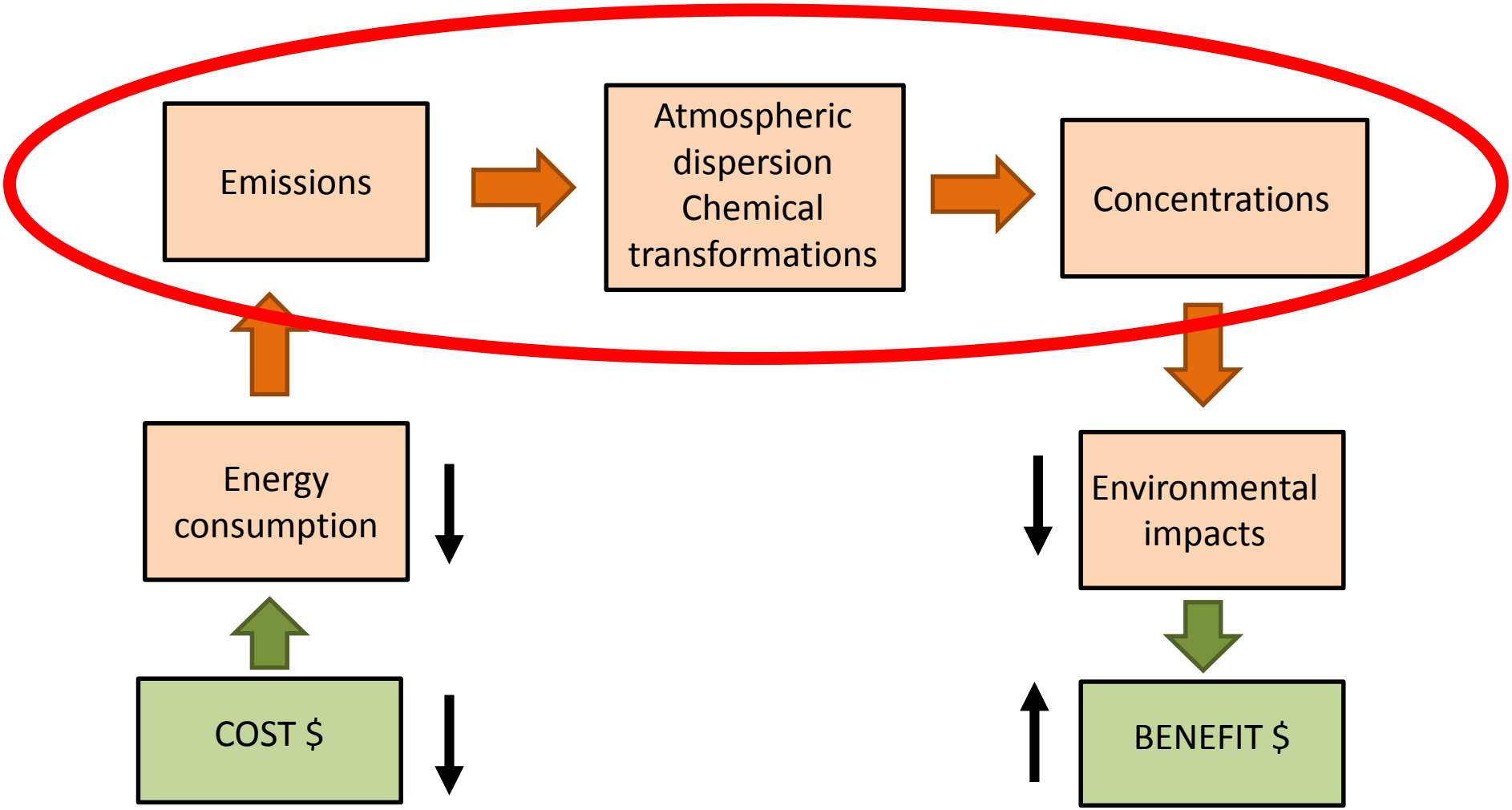
1959: Cuban socialist revolution succeed.
American trade embargo and support of Soviet Union are set up.

1991: Soviet subsidies and trade links are withdrawn.
Energy consumption drops for more than **40%** in **4 years**.
(1772 kg equivalent oil/inhab. in 1989 to 1004 in 1993).
Energy supply by Cuban resources becomes an essential issue for the country.

2006: Cuban Energy Revolution starts:
Increase energy efficiency and renewable energy production.

The development of new energy strategies requires to be funded but it has also consequences on the environment and therefore on the economy

Energy and Air Quality Management



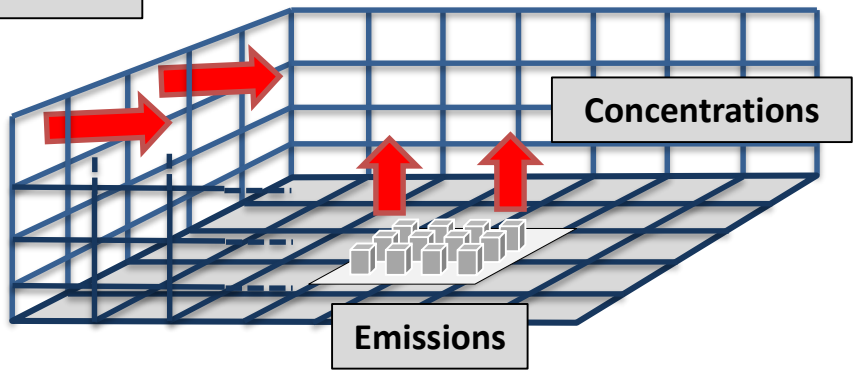
Atmospheric Models: WRF + CHIMERE

Air Quality simulations have been already performed by the “Centro de Gestión de la Información y Desarrollo de la Energía” (CubaEnegia):

Air Quality Model: CHIMERE

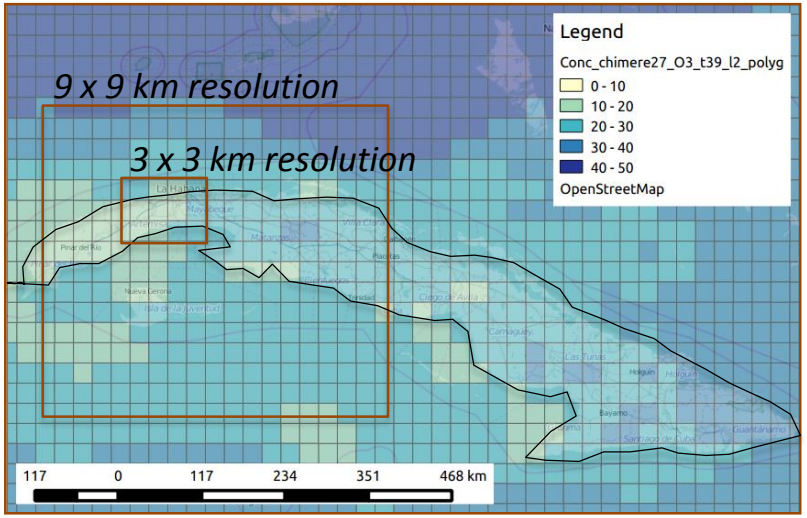
Boundary conditions

Meteorological conditions simulated by **WRF**: Wind, Temperature, Solar radiation



Model domains

27 x 27 km resolution



Leonor Turtos et al.: Assessment of the Weather Research and Forecasting model implementation in Cuba addressed to diagnostic air quality modeling, *Atmospheric Pollution Research*, 01/2013; 4:64-74. DOI:10.5094/APR.2013.007.

EDGAR Emission Inventory

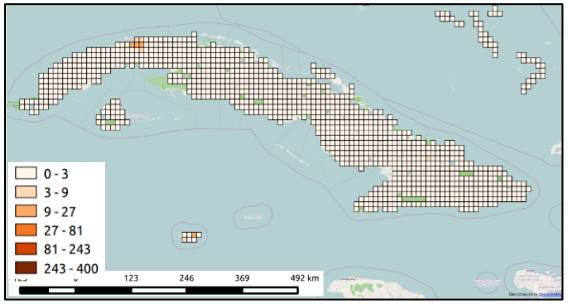
Cuban simulations were based on the **Emissions Database for Global Atmospheric Research** (**EDGAR**).

EDGAR provides **global** past and present day **anthropogenic emissions** of greenhouse gases and air pollutants by country and **on spatial grid**.

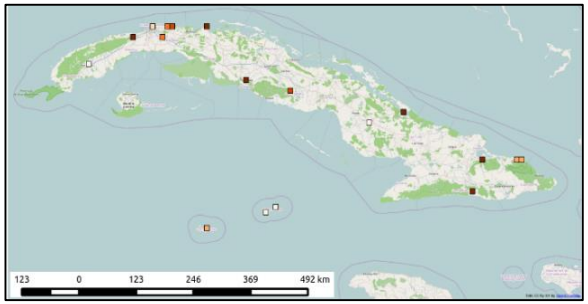
Its current development of is a joint project of the European Commission Joint Research Centre (JRC) and the Netherlands Environmental Assessment Agency (PBL).

EDGAR & CHIMERE grids

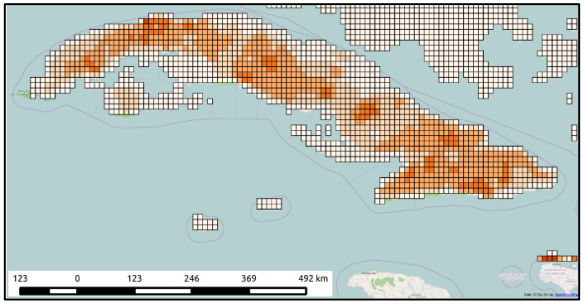
EDGAR grid: 0.1° x 0.1° ≈ 12 x 12 km



Road traffic



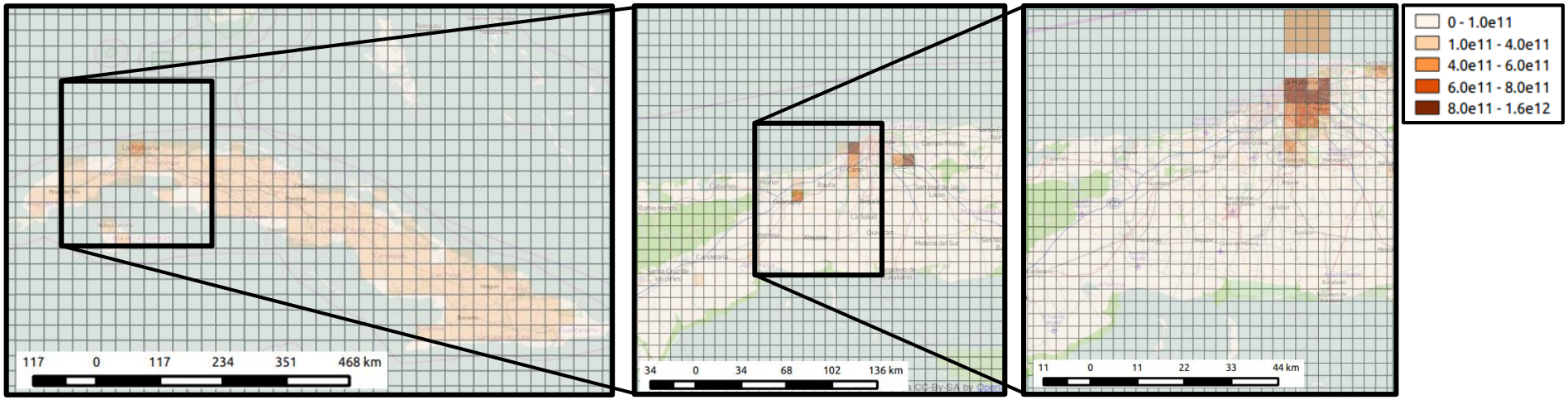
Heat Plants – Electricity generation



Residential - Agriculture

.....

CHIMERE grids



27 x 27 km resolution

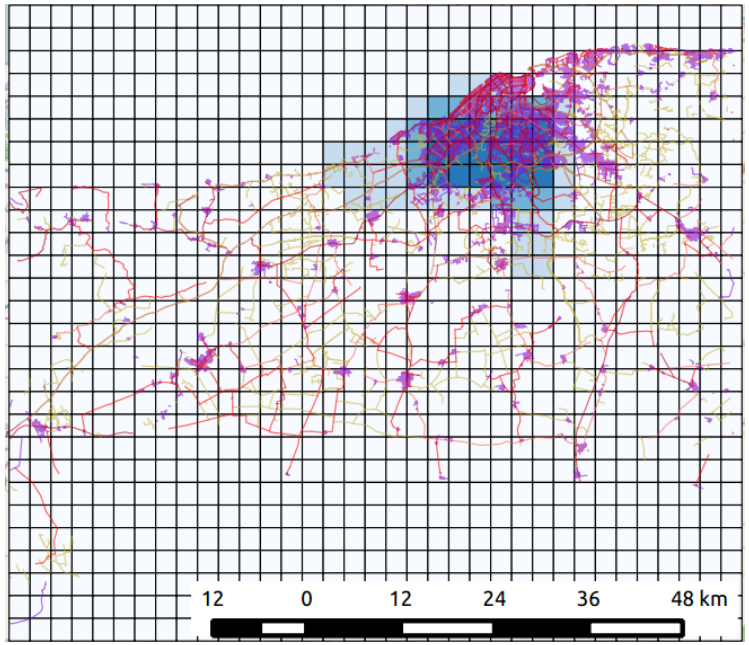
9 x 9 km resolution

3 x 3 km resolution

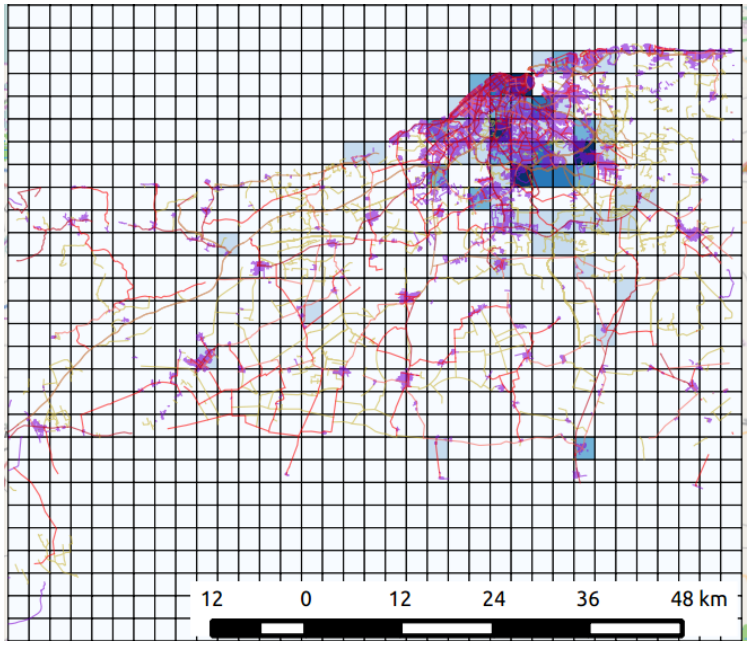
EDGAR & EMISENS inventories

CHIMERE grid, 3 x 3 km resolution, road traffic emissions.

EDGAR



EMISENS

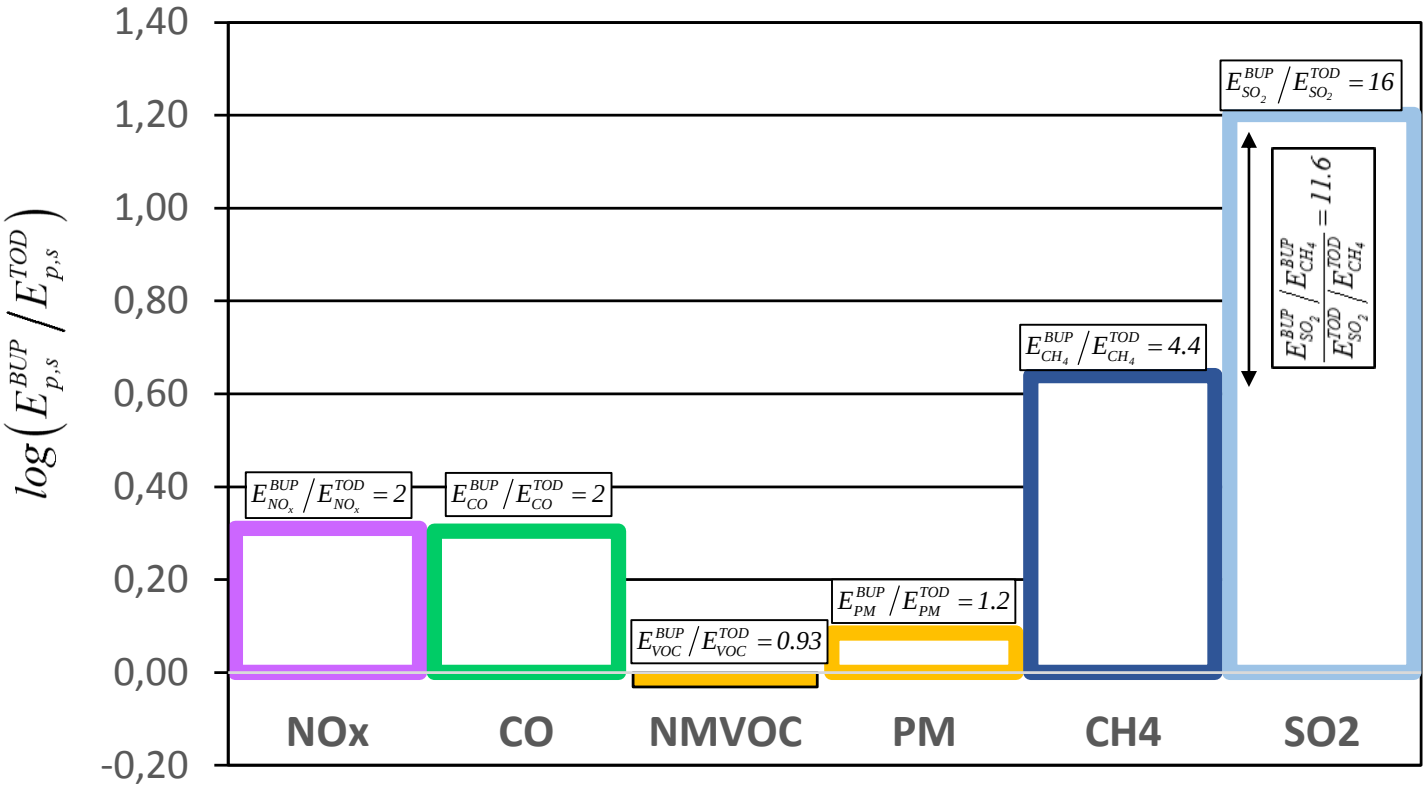


Substitute the **top-down EDGAR emission inventory** by a **bottom-up emission inventory calculated by the EMISSENS model** on the smaller domain.

Ho, Q., B., A. Clappier and N. Blond, 2014: Fast and optimized methodology to generate road traffic emission inventories and their uncertainties, *Clean-Soil,Air,Water*, **42**, 1344-1350.

Comparison of the Top-Down and Bottom-Up inventories

Total emission on the smaller grid



M. Guevara et al., 2015, A benchmarking tool to screen and compare 1 bottom-up and top down emission 2 inventories, *submitted to Environ. Soft. and Mod.*

Comparison of the Top-Down and Bottom-Up inventories

Emission factors and activities

$$E_{p,S}(x,y) = e_{p,S} \times A_S(x,y)$$

$e_{p,S}$ is the emission factors (constant in space and time)

A_S is the activity

p, pollutant

S, macro-sector

$$\frac{E_{SO_2}^{BUP} / E_{CH_4}^{BUP}}{E_{SO_2}^{TOD} / E_{CH_4}^{TOD}} \approx \frac{e_{SO_2}^{BUP} A^{BUP} / E_{CH_4}^{BUP} A^{BUP}}{e_{SO_2}^{TOD} A^{TOD} / e_{CH_4}^{TOD} A^{TOD}} = \frac{e_{SO_2}^{BUP} / e_{CH_4}^{BUP}}{e_{SO_2}^{TOD} / e_{CH_4}^{TOD}} = 11.6$$

Ratios shows large inconsistencies between the emission factors of the 2 inventories.

EDGAR & EMISENS inventories

The emission factors used for the bottom-up emission inventory are "probably" more accurate than the emission factors used for the top-down emission inventory (they have been estimated using emission factors of "comparable" countries).

If the emission factor of the EDGAR (top-down) emission inventory has to changed, it should be changed also over the larger domains.

How to use the EMISENS (bottom-up) emission inventory over the smaller domain to improve the EDGAR (top-down) emission inventory over the larger domains?

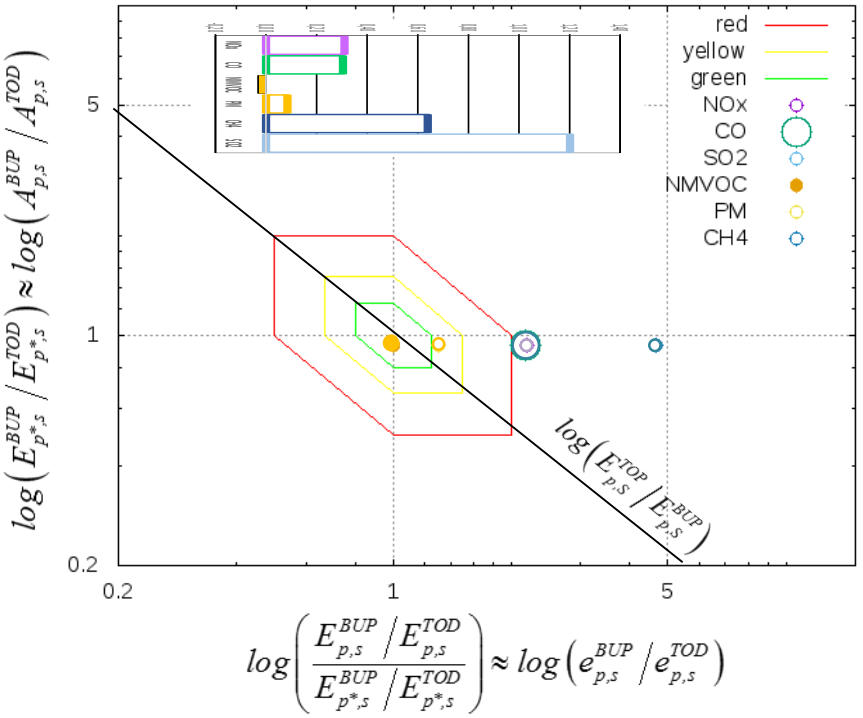
Use the methodologies studied in the Forum for Air Quality Modelling (**FAIRMODE**) : www.fairmode.jrc.ec.europa.eu

Correction of the Top-Down inventory

The Diamond diagram gives a similar information as the Bar plot on its horizontal axis.

The Diamond plot "projects" the difference between the two inventories on two axes: the vertical axis showing a difference between activities and the horizontal axis between emission factors. This projection depends of a reference (p^*) which is arbitrarily chosen.

$$\frac{E^{BUP}_{p^*,S}}{E^{TOD}_{p^*,S}} = \frac{e^{BUP}_{p^*,S} A^{BUP}_{p}}{e^{TOD}_{p^*,S} A^{TOD}_{p}} \approx \frac{A^{BUP}_{p}}{A^{TOD}_{p}}$$

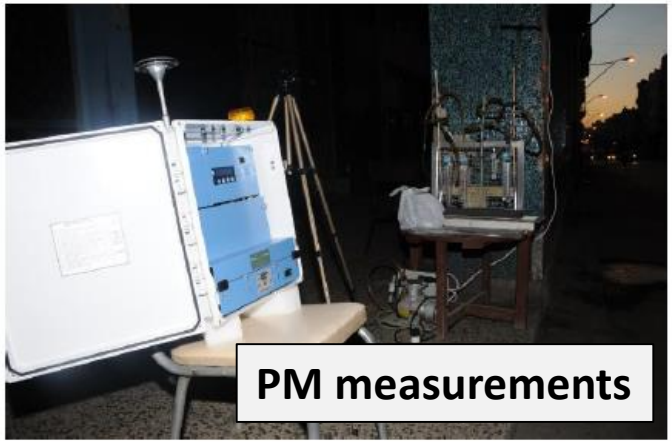


P. Thunis et al., 2015, A novel approach to screen and compare 1 bottom-up vs. top-down emission inventories, *submitted to Atmos. Environ.*

Perspectives

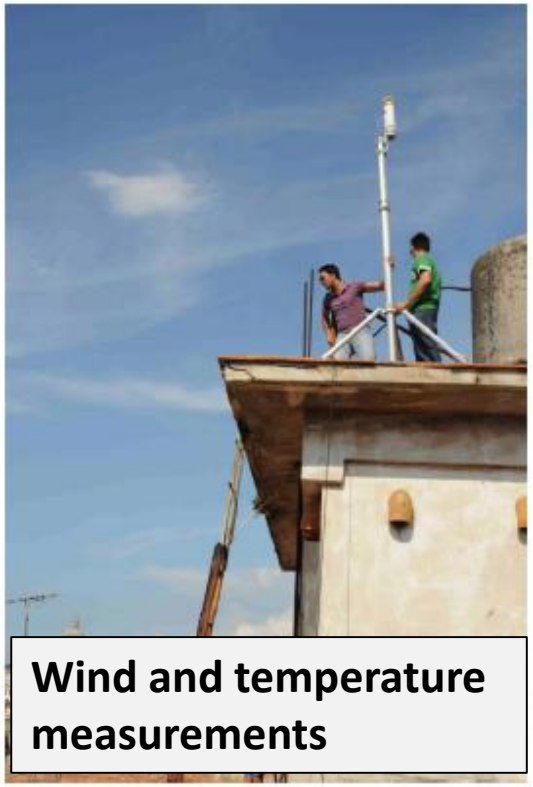
Estimation of Traffic Emission Factors

Measurement campaign in different streets of La Havana: July 2015



PM measurements

Traffic counting

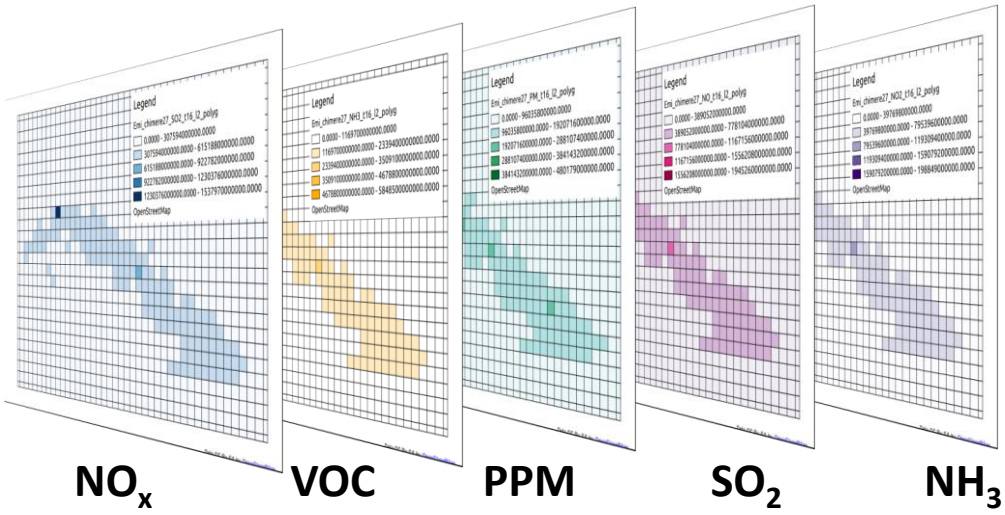


Wind and temperature measurements

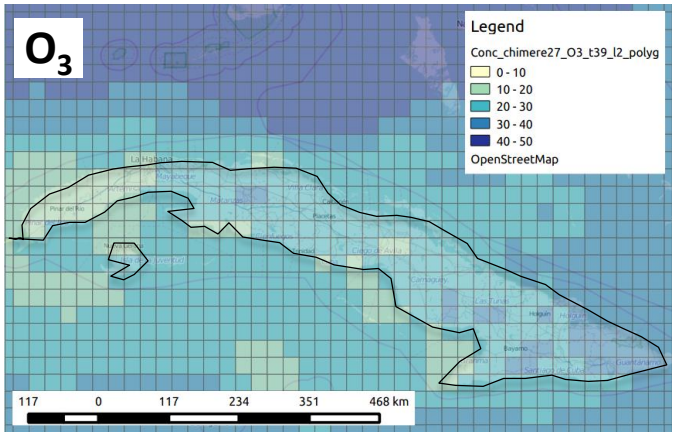
Air Quality Simulations

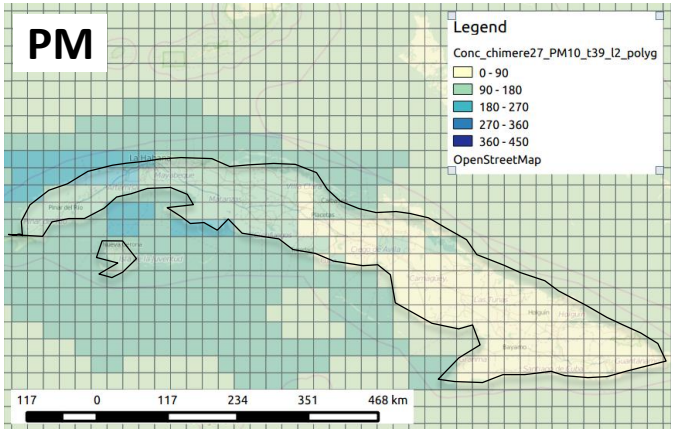
1 year simulation: 2013

Averaged emissions per hour



Every hour concentrations:
Ex: January 2d, 2013, 16:00






Muchas Gracias!
www.flickr.com/lauraolejua